Center for Reliability Growth

AMSAA
Excellence in Analysis

CRG Overview

- DUSA-TE sponsored effort between ATEC & AMSAA
  - Stood up in FY11
- Mission
  - Provide the Army acquisition community with the policies, guidance, standards, contractual language, methods, tools, and training required to rapidly develop systems that meet the Soldier's reliability requirements and fit within the Army's budget
- Functions
  - Archive reliability data from ACAT I/II programs, capture lessons learned, and generate success metrics
  - Develop and propose policy refinements, reliability guidance/standards, improved reliability methodology/tools, reliability training to the acquisition workforce
  - ***Identify and execute reliability improvement initiatives now to save the Department money and improve systems for our Soldiers***

- DUSA-TE = Deputy Under Secretary of the Army - Test and Evaluation
- ACAT - Acquisition Category

Recent Initiatives

Test Efficiencies

- Wheeled vehicle system: reduced testing by $400K
- Protective shelter system: $390K test cost avoidance
- Ground vehicle system: saved $170K on testing weight impacts of additional armor
- Wheeled vehicle system: potential millions saved by suspension upgrade insights
- Bridge system: $3.1M reduction through M&S

Big Data

- Use of CBM data to improve development of system OMS/MP
- Bayesian Fusion: structured method to take other data sources into account when assessing system reliability, resulting in decreased testing & reduced risk
- New RAM T&E Data Repository

Focused System Efforts

- Independent reliability review for PM of small arms system to determine “as is” and “to be” system reliability
  - New test analysis methodology
- Independent review of rotary-wing aircraft failure modes using reliability engineering analysis for PM, AMRDEC, and DOT&E

Software, Risk, Training, and More

- Approach to system reliability improvement beyond Milestone C
- Quantified impact of increased weight on reliability
- Software reliability: PPSS analysis identified $65M savings per year
- Early reliability risk assessments
- Reliability lessons learned
- CRG reliability tools and contractual language used by over 600 customers across DoD and industry

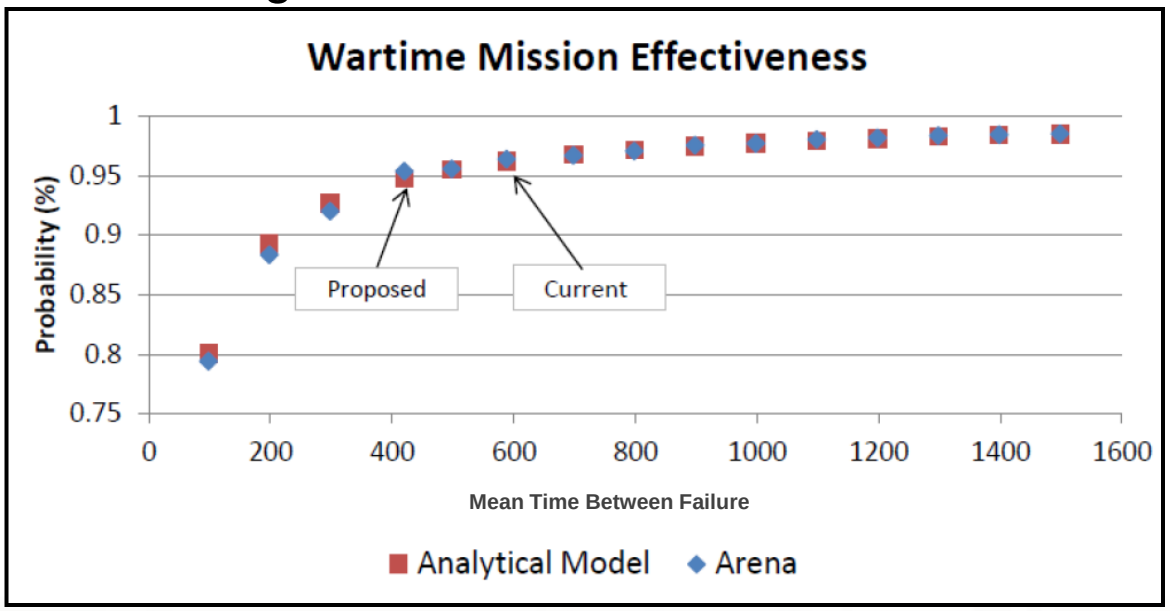
Better reliability, lower costs, and faster fielding

- M&S = Modeling & Simulation
- CBM = Condition Based Maintenance
- OMS/MP = Operational Mode Summary/Mission Profile
- T&E = Test & Evaluation
- PPSS = Post Production Software Support

Requirements Reviews

- Leveraging fill rates and delay times currently experienced in field
- Mission times and OPTEMPO based on SDC data for platform vehicles
- Analysis includes simulation and Markov Chain modeling

Additional FY14 study examining reliability & mission effectiveness



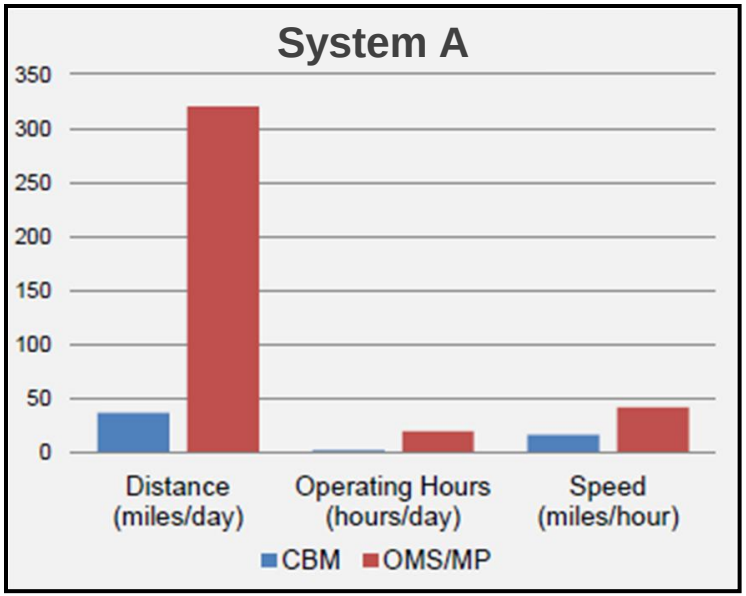
Model Input Parameters
Mission Time
Operation Tempo
Software Failures
Authorized Stockage List (ASL) Fill Rate
ASL Delay (O-Level)
Not in stock at ASL Delay (Depot Level)
Average Logistics Delay Time (ALDT)
Mean Time To Repair (MTTR)
% Common Failures

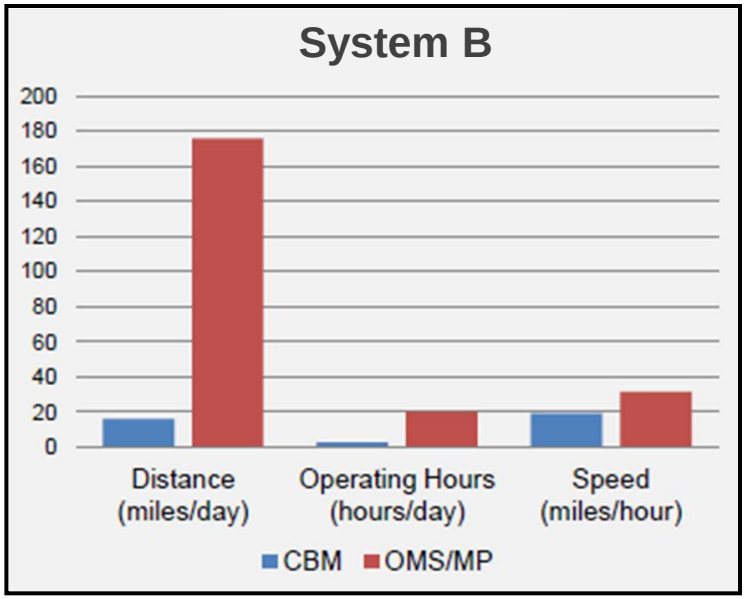
Potential to save $$ by optimizing requirements

- SDC = Sample Data Collection

CBM Data & OMS/MP Refinement

Comparison of CBM Data to OMS/MP Values





- ❑ Big Data shows great promise for refining OMS/MP values
- ❑ Data and analysis is readily available through CBM Portal

OMS/MP improvements = $$$ & time savings

- CBM = Condition Based Maintenance
- OMS/MP = Operational Mode Summary/Mission Profile

CRG RAM T&E Repository

CRG Knowledge Archive

16,626 files (~37 GB)

ACAT I	164
ACAT II	65
ACAT III	486
RI/Other	484

Program Documents

- Acquisition Strategy
- Capability Development Document (CDD)
- Capability Production Document (CPD)
- Failure Definition/Scoring Criteria (FDSC)
- Test and Evaluation Master Plan (TEMP)
- Test Reports (e.g., OMAR, OER)
- Etc.

RAM Analysis

- Failure Timelines
- Mean Cumulative Function (MCF) Plots
- Box Plots
- Etc.

Raw Data

- Test Incident Reports (TIRs)
- Excel and PDF files of data
- Etc.

MS Access Database

System Information

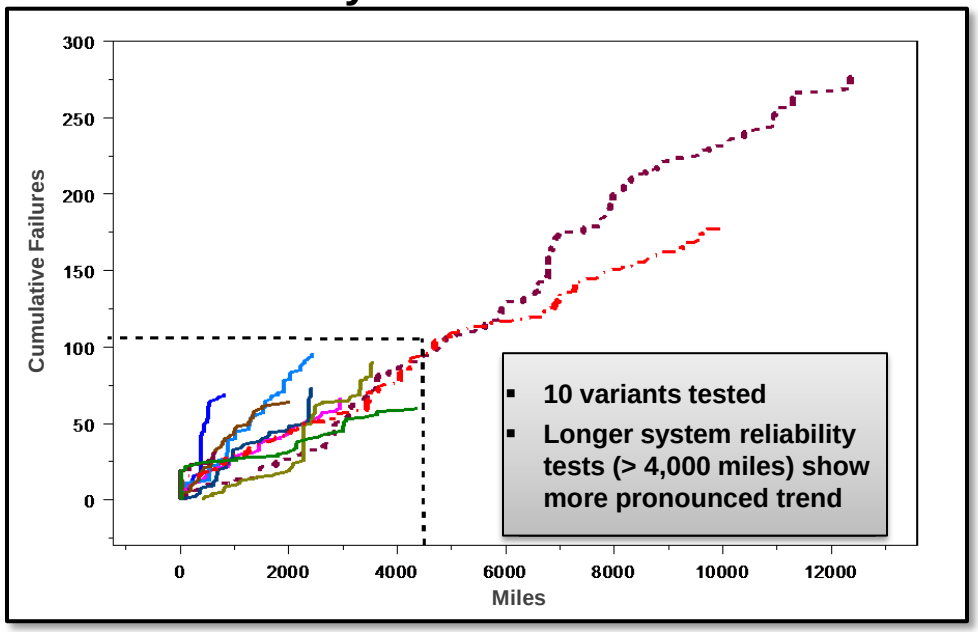
- Name
- ACAT
- PEO
- Commodity
- Subsystems/Variants
- Status
- Links to Documents
- Rel. Growth Parameters
- RAM Requirements

Test Events

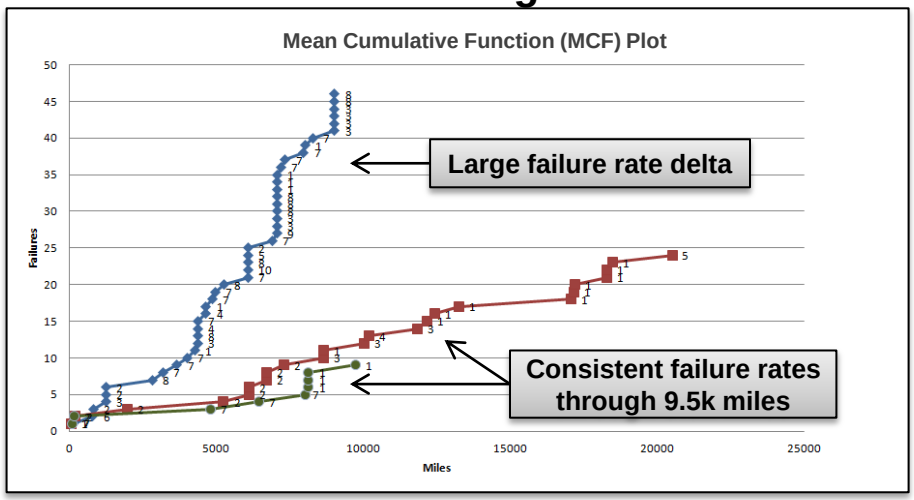
- Event type and name
- Event year
- Event order
- Results

Sample CRG Studies

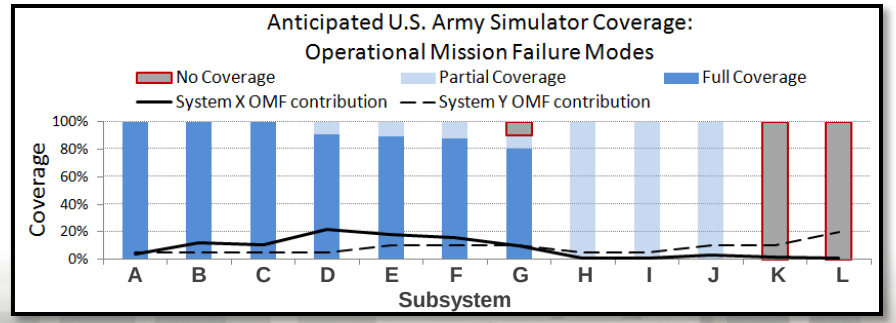
Failure Data for 10 Ground Vehicle System Variants



Subsystem Failure Comparison for 3 Vehicle Configurations



Assessment of Army Vehicle Simulator Labs



Bayesian Test Efficiency: IOT Demonstration Comparison

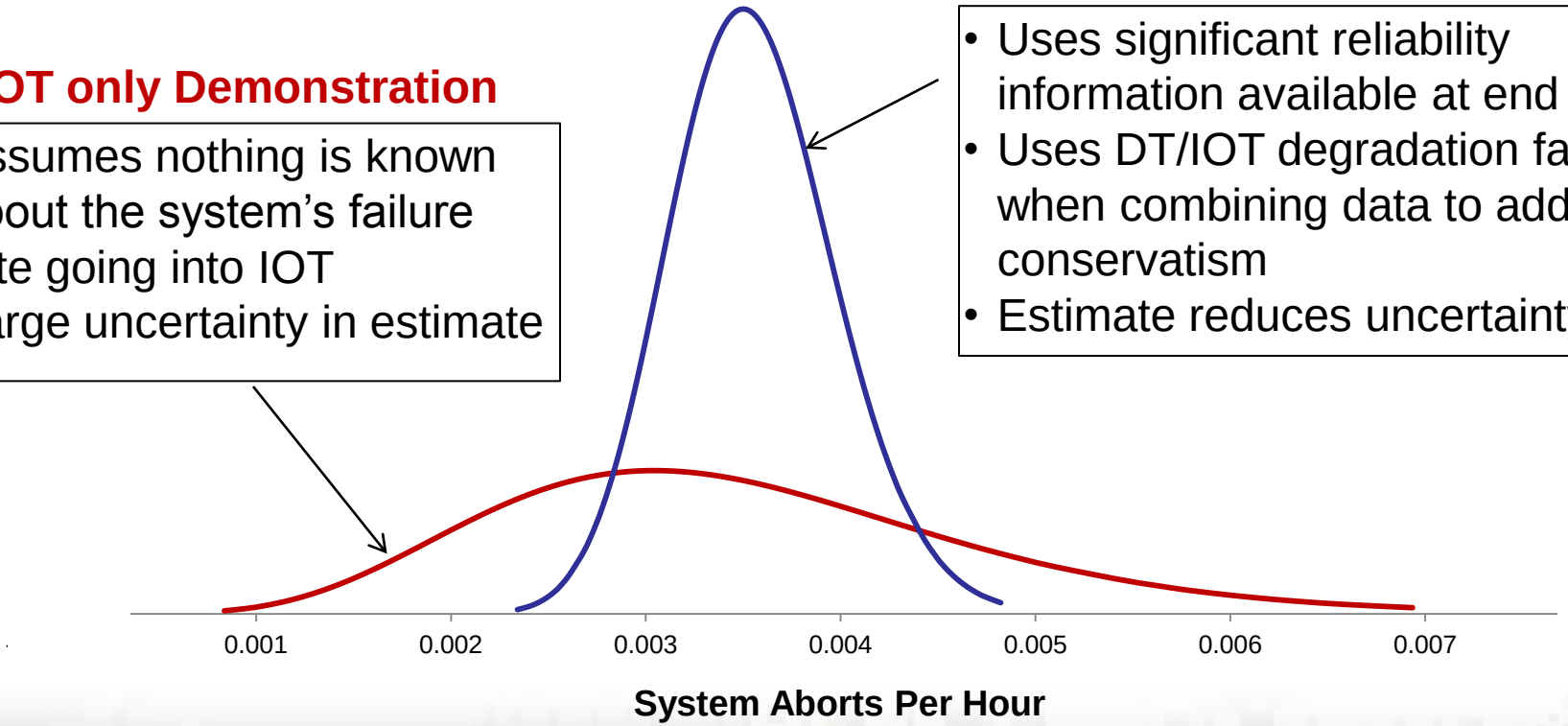
- Piloting methodology on two non-oversight systems

IOT only Demonstration

- Assumes nothing is known about the system's failure rate going into IOT
- Large uncertainty in estimate

Combined DT/IOT Demonstration

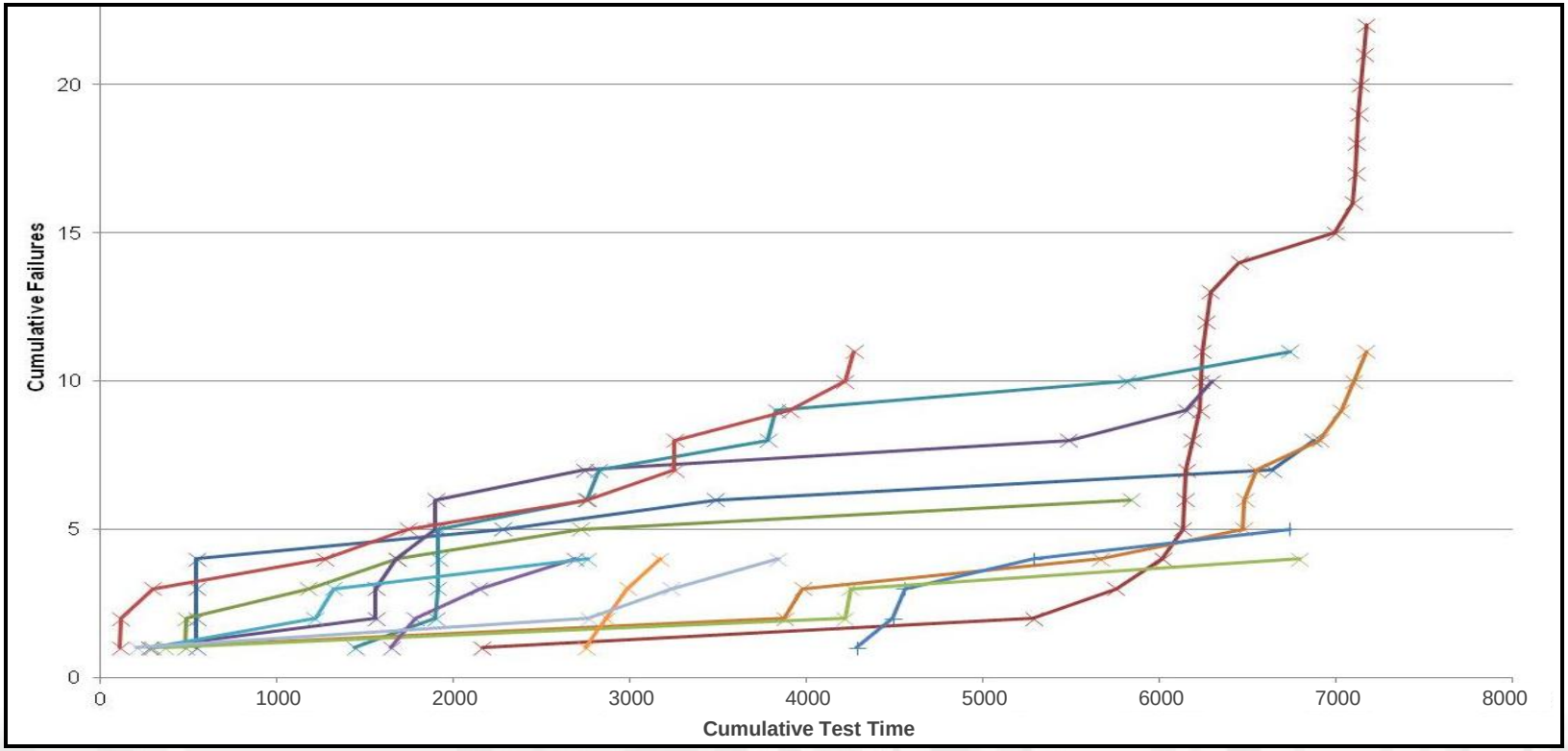
- Uses significant reliability information available at end of DT
- Uses DT/IOT degradation factor when combining data to add conservatism
- Estimate reduces uncertainty



- DOT&E = Director, Operational Test and Evaluation
- IOT = Initial Operational Test
- DT = Developmental Test

Failure Analysis Methodology

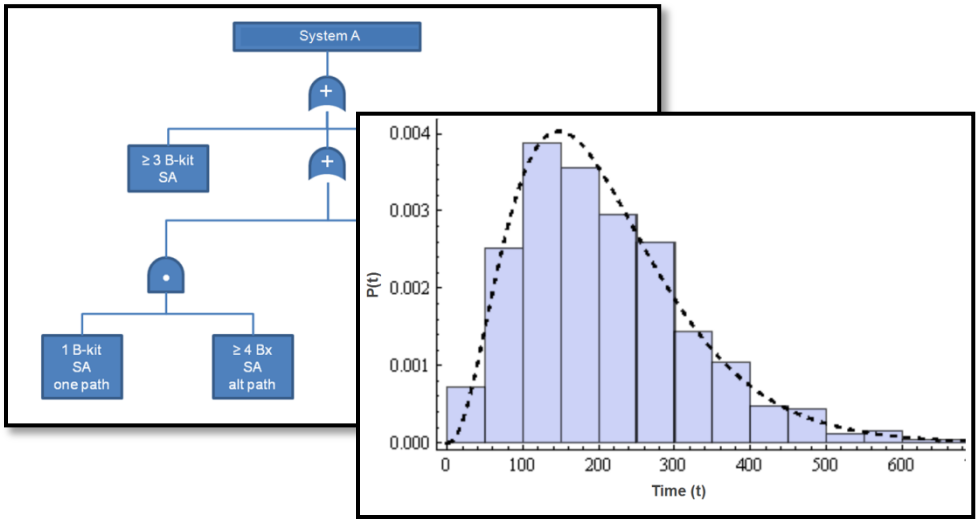
- Analyzed system level reliability test data for 13 test units
  - Multiple variants and test variables
- Analysis identified wide variation in failure rates, precluding modeling with current methods



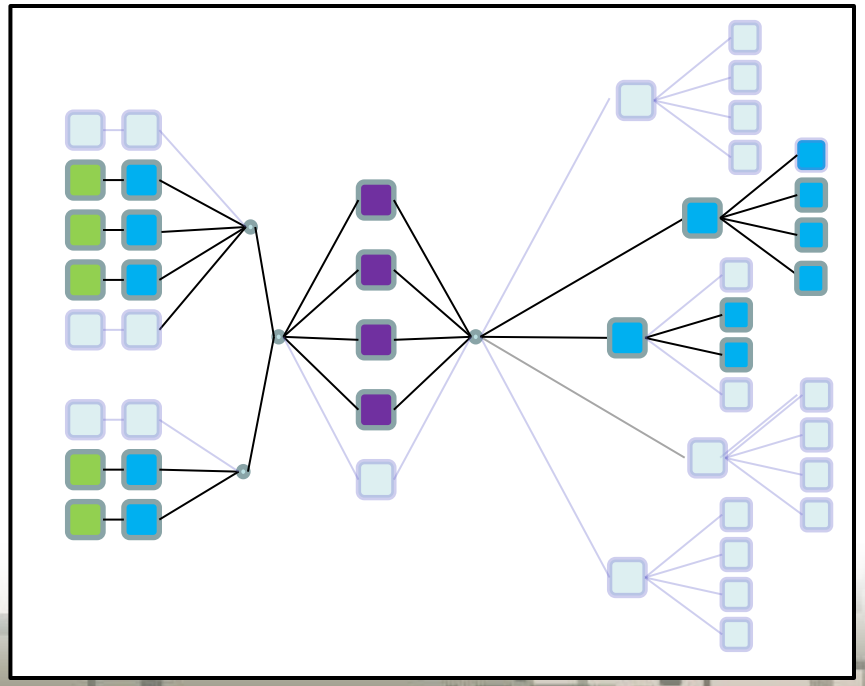
Currently finalizing experimental design approach

System of Systems Reliability

Empirical M&S Approach vs. Full System Test



Operational Test configuration is a subset of the field configuration



System-Level $R_i(t) = e^{-\lambda_i t}$

Group-Level $R_{KN_i}(t) = \sum_{i=k}^{n} \binom{n}{i} \cdot R_i(t)^i \cdot [1 - R_i(t)]^{n-i}$

SoS-Level $R_{SoS}(t) = \prod_{i=1}^{N} R_{KN_i}(t)$

Adaptive Evaluation Risk Framework

- Developed methodology and guidance for designing reliability test programs (RTPs)
  - Emphasis on adequacy and evaluation risk . . . *It's more than statistical confidence*
  - Risk assessment framework appropriate for all commodity areas
- Leveraging system's RAM T&E data (captured during test programs) to inform development of methodology and guidance
  - Representative cross-section of commodity areas
- Risk assessment framework and RTP planning guidance can expand or contract to suit the needs of the user, T&E, PM, developer, and oversight communities
- Built-in capability to assess the impact of evaluation risk trades on RTP adequacy and resource requirements

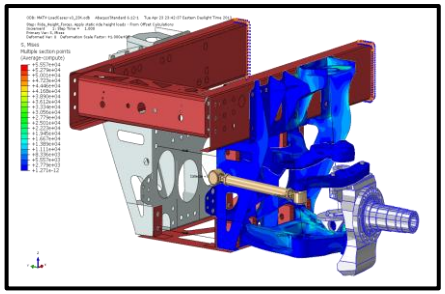
One of ten key initiatives of the T&E Efficiencies Task Force Systemic Opportunity Working Group for Reliability

▪ T&E = Test and Evaluation

Modeling & Simulation Applications

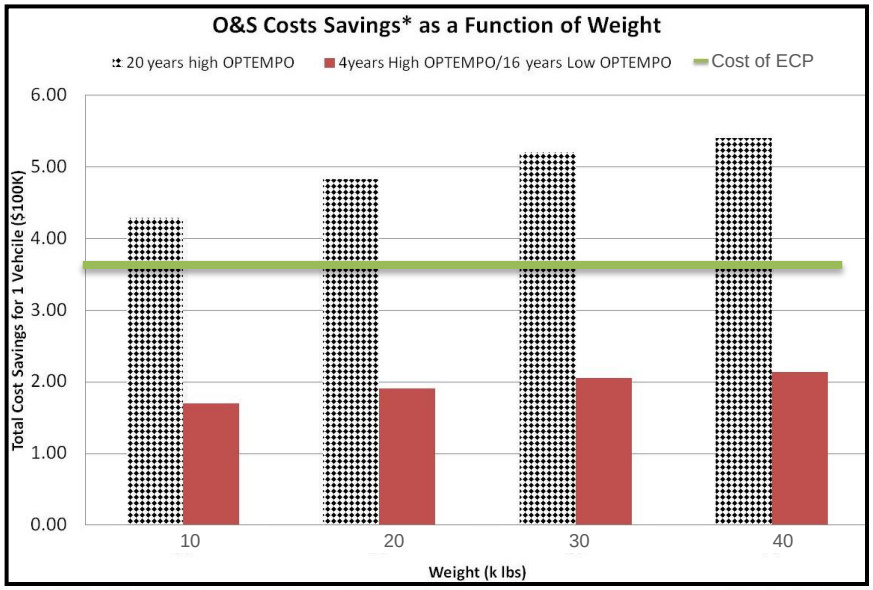
Wheeled Vehicle System A:
Efficient use of current simulation facilities and computer-based analytical capabilities to expedite system reliability growth and reduce testing miles and hours

Durability Simulation



Modeling & Simulation

Wheeled Vehicle System B ECP:
Conducted analysis using new engineering approach to address impact weight can have on vehicle to support CBA



- ECP = Engineering Change Proposal
- CBA = Cost Benefit Analysis

Reliability Growth Models

Excel based models available through amsaa.reltools@us.army.mil

- Reduces risk
- Constructs feasible reliability test programs
- Helps link engineering efforts & program constraints with overall reliability program

Over 600 customers across DoD and industry

Planning	Assessment	
	Tracking	Projection
• PM2 – Continuous • PM2 – Discrete	• RGTM – Continuous	• ACPM • AMPM • ADPM
Additional details on all models can be found in MIL-HDBK-189C		

- PM2 = Planning Model based on Projection Methodology
- RGTM = Reliability Growth Tracking Model
- ACPM = AMSAA-Crow Projection Model
- AMPM = AMSAA Maturity Projection Model
- ADPM = AMSAA Discrete Projection Model

AMSAA Reliability Scorecards

- Structured engineering and analytical approach to identify weak performers early in program development
- Can be applied throughout life cycle of system
- General version along with software specific version
  - Each scorecard divided into multiple categories
  - Each category contains several elements with associated rating criteria
  - Each element is rated and rationale and suggestions to decrease risk are provided

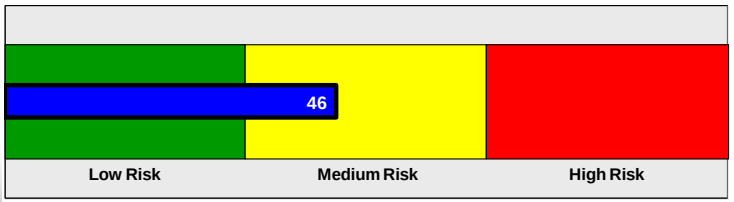
General Version

40 Elements, 8 Categories
- Reliability Requirements & Planning
- Training & Development
- Reliability Analysis
- Reliability Testing
- Supply Chain Management
- Failure Tracking & Reporting
- Verification & Validation
- Reliability Improvements

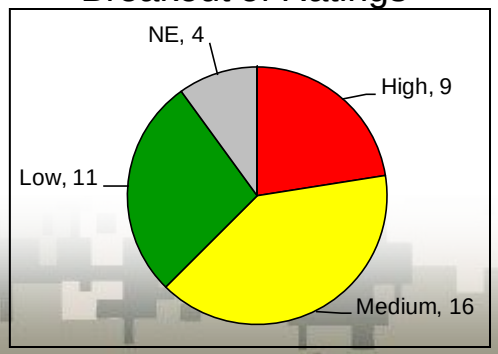
Software Version

57 Elements, 7 Categories
- Program Management
- Requirements Management
- Design Capabilities
- System Design
- Design for Reliability
- Testing & Acceptance
- Fielding & Sustainment

Overall Risk Assessment



Breakout of Ratings



Reliability Contractual Language

- Designed to help DoD and industry identify reliability items for inclusion when drafting a statement of objectives (SOO), statement of work (SOW), and request for proposal (RFP) during solicitation and contract execution
- Based on elements of
  - MIL-HDBK-785B – a task-based HDBK canceled in July 1998
  - GEIA-STD-0009 “Reliability Program Standard for Systems Design, Development, and Manufacturing” – systems engineering and management based standards for reliability programs
- Focuses on Milestone B contracts and employs one-time use Data Item Descriptions (DIDs)
- Future plans:
  - Tailor language for post MS B contracts
  - Coordinate DIDs across Services

Contact CRG for any Reliability Challenges

amsaa.reltools@us.army.mil